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(54) [Title of the Invention] ZOOMING DEVICE AND OPTICAL
INSTRUMENT

(57) [Abstract]

[Problem] In a zooming device comprising a main diaphragm and a sub-diaphragm, there occurs a problem, in that the brightness and darkness ratio in a screen peripheral area is increased and the peripheral light quantity becomes insufficient since the distance between both diaphragms.

[Solving Means] In a zoom lens comprising a diaphragm device 24 capable of performing the diaphragming up to a small aperture and a sub-diaphragm 26 to determine the open FNO at each focal distance in an interlocking manner with the zooming operation, the diaphragm device 24 is driven to a vicinity of the open FNO luminous flux even in an open state by the zooming operation.

[Claims]

[Claim 1] A zooming device comprising: a diaphragm device capable of performing the diaphragming up to a small aperture; and a sub-diaphragm to determine an open FNO at each focal distance in an interlocking manner with the zooming operation, wherein the diaphragm device is driven even in an open state by the zooming operation.

[Claim 2] The zooming device according to Claim 1, wherein the diaphragm device is driven to a vicinity of a FNO luminous flux at each focal distance.

[Claim 3] The zooming device according to Claim 1, wherein the focal distance is detected by a zoom encoder.

[Claim 4] The zooming device according to Claim 1, wherein the diaphragm device uses a stepping motor for a drive source.

[Claim 5] The zooming device according to Claim 1, wherein the sub-diaphragm determines the open FNO other than that at a TELE end in an interlocking manner with the zooming operation.

[Claim 6] The zooming device according to any one of Claim 1 to Claim 5, wherein the sub-diaphragm is located behind the diaphragm device.

[Claim 7] The zooming device according to any one of Claim 1 to Claim 5, wherein the diaphragm device performs the diaphragming to a vicinity of the optical FNO in an

interlocking manner with the zooming operation in an open state.

[Claim 8] An optical instrument having the zooming device according to any one of Claim 1 to Claim 7.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention relates to a zooming device comprising a main diaphragm capable of performing the diaphragming by changing the diameter of the open aperture (FNO), and a sub-diaphragm which is located behind the main diaphragm to change the diameter of the open aperture in an interlocking manner with the zooming operation, in particular, it relates to a wide angle zooming device and an optical instrument.

[0002]

[Description of the Related Art] A motor-driven diaphragm device having a diaphragm diameter correction mechanism capable of correcting the diameter of the open aperture in an interlocking manner with the zooming operation has been developed by the Applicant, and put into practical use. The motor-driven diaphragm device having the diaphragm diameter correction mechanism is disclosed in Japanese Unexamined Patent Application Publication No. 3-15834, and determines the open FNO at the open diameter (the fixed open diameter in the diaphragm device) at a Tele end, forms the open

diameter of the open aperture by the diaphragm blade itself from a vicinity of Tele to a wide end, and determines the open FNO by the diameter of the open aperture. In other words, the motor-driven diaphragm device is capable of performing the diaphragming to a small aperture because the FNO is changed by one motor-driven diaphragm device (the main diaphragm), and has a diaphragm diameter correction mechanism to change the diameter of the open aperture in an interlocking manner with the zooming operation.

[0003] Further, another known zooming device comprises two diaphragm devices, i.e., a motor-driven diaphragm device (a main diaphragm), and a sub-diaphragm to change the diameter of the open aperture in an interlocking manner with the zooming operation.

[0004]

[Problems to be Solved by the Invention] However, the diaphragm device is increased in size and unfavorable in space since the zooming device having one above-described motor-driven diaphragm device is capable of performing the diaphragming up to a small aperture, and also used for correction of the diameter of the open aperture, raising a problem, in that a compact lens barrel cannot be achieved.

[0005] On the other hand, in the zooming device comprising two diaphragm devices, i.e., a main diaphragm capable of performing the diaphragming up to a small aperture and a

sub-diaphragm to change the diameter of the open aperture in an interlocking manner with the zooming operation, the distance between the main diaphragm and the sub-diaphragm is large, more light enters in an intermediate portion of a screen than the above-described one motor-driven diaphragm device which is capable of performing the diaphragming up to the small aperture and also used for correcting the diameter of the open aperture, and the brightness and darkness ratio with a screen peripheral (diagonal) area is increased, raising a problem of insufficient peripheral light quantity.

[0006] The present invention is achieved to solve the above-described problem, and an object of the present invention is to provide a zooming device and an optical instrument capable of limiting the incident light quantity on the intermediate portion of the screen, and mitigating the brightness and darkness ratio of the light quantity between the intermediate portion of the screen and the peripheral portion of the screen.

[0007]

[Means for Solving the Problems] A zooming device of the invention according to Claim 1 comprises a diaphragm device capable of performing the diaphragming up to a small aperture and a sub-diaphragm to determine the open FNO at each focal distance in an interlocking manner with the zooming operation, and drives the diaphragm device even in

an open state by the zooming operation.

[0008] The zooming device of the invention according to Claim 2 drives the diaphragm device to a vicinity of the FNO luminous flux at each focal distance.

[0009] The zooming device of the invention according to Claim 3 detects the focal distance by a zoom encoder.

[0010] The zooming device of the invention according to Claim 4 uses a stepping motor for a drive source of the diaphragm device.

[0011] The zooming device of the invention according to Claim 5 determines the open FNO other than a TELE end in an interlocking manner with the zooming operation by the sub-diaphragm, and cuts an optical flare.

[0012] The zooming device of the invention according to Claim 6 has the sub-diaphragm which is located behind the diaphragm device.

[0013] The zooming device of the invention according to Claim 7 limits the incident light quantity in an intermediate portion of a screen by performing the diaphragming of the diaphragm device to a vicinity of the optical FNO in an interlocking manner with the zooming operation in an open state.

[0014] An optical instrument of the invention according to Claim 8 has the zooming device according to any one of Claim 1 to Claim 7.

[0015]

[Embodiments] An embodiment of the present invention will be described below.

[0016] Embodiment 1. Fig. 1 is a longitudinal sectional view of a zooming device in a wide state according to the embodiment 1 of the present invention. In the figure, reference numeral 1 denotes a guide barrel, and reference numeral 2 denotes a cam barrel which is turnably inserted in an inside diameter part of the guide barrel 1. A first moving frame 3 for first lenses G1, G2 and a second moving frame 4 for second and fourth lens groups G3, G4, G7 and G8 are inserted in the inside diameter part slidably in the direction of the optical axis. A cam follower 3a implanted in the first moving frame 3 by screws or the like and a cam follower 4a implanted in the second moving frame 4 by screws or the like are fitted in straight guide grooves 1a and 1b formed in the guide barrel 1, respectively, and further fitted in cam grooves 2a and 2b formed in the cam barrel 2, respectively.

[0017] A third moving frame 5 for third lens groups G5 and G6 are inserted in the inside diameter part of the second moving frame 4 slidably in the direction of the optical axis, and a cam follower 5a implanted in the third moving frame 5 by screws or the like is fitted in a straight guide groove 4b formed in the second moving frame 4, and also fitted in

the cam groove 2c formed in the cam barrel 2.

[0018] A holding frame 6 to hold a part of the lens G2 of the first lens groups G1 and G2 is inserted in the inside diameter part of the first moving frame 3, and a cam follower 6a implanted in the holding frame 6 by screws or the like is fitted in the cam groove 3b of the first moving frame 3. Further, a focus key 8 to directly convey the turn of a known ultrasonic motor 7 as a stepping motor is fitted in a focus adjustment block 9 mounted on the holding frame 6 by screws or the like.

[0019] A holding ring 10 to hold a part of the lens G1 of the first lens groups G1 and G2 is screwed to a tip of the first moving frame 3. A hood mounting ring 11 coupled with the guide barrel 1 by a screw 23 is provided on an outer circumferential part of the holding ring 10, a manual ring 12 is turnably fitted in an outer circumferential part of the guide barrel 1, and a manual rubber 13 is wound around an outer circumferential surface thereof.

[0020] The cam barrel 2 is connected to the zoom ring 16 by the zoom key 14 fixed to the cam barrel 2 by screws and the zoom roller 15. A zoom rubber 17 which is also used for a holder of a zoom play removing piece 18 is wound around an outer circumferential part of the zoom ring 16. In addition, a zoom brush 19 for a zoom encoder is fixed to the zoom key 14.

[0021] A fixed cylinder 21 to be coupled with a mount 20 is screwed to a rear portion of the guide barrel 1, and a mounted substrate 22 is arranged between the mount 20 and the fixed cylinder. The mount 20 is engaged with a mount (not shown) of a camera body side 30 as an optical instrument.

[0022] The zoom ring 16 is rotatably fitted in the fixed cylinder 21, and thrust-regulated to the zoom key 14 by the zoom roller 15, the manual ring 12 is rotatably fitted in the guide barrel 1, and thrust-regulated by an end 7b of a connection ring 7a of the ultrasonic motor 7 and an end 21a of the fixed cylinder 21.

[0023] A motor-driven diaphragm device (a main diaphragm) 24 capable of performing the diaphragming up to a small aperture is mounted on the third moving frame 5 by the screw 25, and a sub-diaphragm 26 to determine the open FNO is mounted on a rear portion. The sub-diaphragm 26 comprises a holding plate 26a, a swage block 26b and a diaphragm blade 26c, a shaft 26d is integrated with the holding plate 26a, and the shaft 26d is pivotably supported by a hole 5b in the third moving frame 5 to regulate the rotation of the holding plate 26a, and mounted on the third moving frame 5 by a patching pawl (not shown) of the holding plate 26a. The swage block 26b is rotatably bayonet-coupled with the holding plate 26a, and the diaphragm blade 26c is

opened/closed to determine the open FNO by rotating the swage block 26b.

[0024] The rotational cam groove 4c of the swage block 26b corresponding to a differential cam between the second lens groups G3 and G4 and the third lens groups G5 and G6 is formed in the second moving frame 4, and the cam follower 26e is connected to the swage block 26b to determine the opening/closing quantity of the diaphragm blade 26c at each zoom area (at each focal distance).

[0025] Next, the operation will be described. By the turn of the known ultrasonic motor 7 or the manual ring 12, the holding frame 6 is turned via the focus key 8 and the focus adjustment block 9, and the focusing is also performed longitudinally in the direction of the optical axis along the cam groove 3b of the first moving frame 3.

[0026] On the other hand, when the zoom ring 16 is turned, the cam barrel 2 is turned via the zoom roller 15 and the zoom key 14, and guided by the cam groove 2a of the cam barrel 2 and the straight guide groove 1a of the guide barrel 1. The first moving frame 3 and the holding frame 6 are similarly guided by the cam groove 2c and the straight guide groove 4b, and the third moving frame 5 is moved along the direction of the optical axis to perform the zooming.

[0027] In this situation, in the sub-diaphragm 26, accompanied by the movement of the second lens groups G3 and

G4 and the third lens groups G5 and G6 in the direction of the optical axis, the swage block 26b is rotated and the diaphragm blade 26c is opened/closed by the cam groove 4c of the second moving frame 4.

[0028] Fig. 2 is an enlarged view of a major part of the motor-driven diaphragm device (the main diaphragm) 24 in the same wide state as that in Fig. 1. In the figure, a two-dot-chain-line 27 indicates the open FNO luminous flux in a wide state, and a solid line 28 indicates a lower beam luminous flux at the image height of 10 mm.

[0029] In the wide open state in Figs. 1 and 2, when the motor-driven diaphragm device (the main diaphragm) 24 is diaphragmed to a vicinity of the FNO luminous flux at a point 29 in Fig. 2, the luminous flux (between the point 29 and the point 30) in a vicinity of the lower beam at the image height of 10 mm can be cut, and the drop of the image height illuminance ratio (the peripheral light quantity) becomes smooth.

[0030] Regarding the driving quantity of the motor-driven diaphragm device (the main diaphragm) 24, the motor-driven diaphragm device (the main diaphragm) 24 is driven by storing the diaphragming quantity (the driving quantity) to the open FNO luminous flux at each focal distance by a microcomputer in advance, and detecting the zoom position by the zoom encoder 19 (by detecting the rotational quantity of

the cam barrel).

[0031] Fig. 3 shows the image surface illuminance ratio in a wide open state. The vertical axis indicates the image surface illuminance ratio in a wide open state. The vertical axis and the horizontal axis indicate the illuminance ratio and the image height, respectively. A broken line and a solid line indicate a state in which the motor-driven diaphragm device (the main diaphragm) 24 is not diaphragmed, and a state in which motor-driven diaphragm device is diaphragmed to a vicinity of the open FNO luminous flux, respectively. As clearly shown from the figure, the brightness and darkness ratio between the intermediate portion of the screen and the peripheral portion of the screen is mitigated, and no photo insufficient in the peripheral light quantity is realized.

[0032]

[Advantages] As described above, according to the present invention, the focal distance is detected by the zoom encoder even in an open state, and the motor-driven diaphragm device (the main diaphragm) is driven to a vicinity of the open FNO luminous flux at the focal distance. Therefore, the incident light quantity in the intermediate portion of the screen can be limited, and any photo insufficient in the incident light quantity or any eclipsed photo can be prevented.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a longitudinal sectional view to show a zooming device according to an embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is an enlarged view of a major part of a motor-driven diaphragm device part in Fig. 1.

[Fig. 3] Fig. 3 shows the image surface illuminance ratio.

[Reference Numerals]

7 ultrasonic motor (stepping motor)

19 zoom encoder

24 motor-driven diaphragm device (main diaphragm)

26 sub-diaphragm

27 FNO luminous flux

FIG. 3

- (1) ILLUMINANCE RATIO
- (2) IMAGE SURFACE ILLUMINANCE RATIO
- (3) IMAGE HEIGHT